



TITLE:

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Water, Livelihood and Health in Attapeu Province in Lao PDR

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Abstract

This paper presents the results of an investigation on water-borne infectious disease conducted among the people of Attapeu province from 2003 to 2008. Regardless of the last cholera epidemic in Attapeu province, Lao PDR in the year 1999, the local peoples' awareness of cholera was remarkably low, as demonstrated by the knowledge survey on diarrheal diseases performed in the province in 2006. In the case study material, derived from continuous field observations on malaria among permanent residents in relocated villages in Sanxay district from 2004 to 2008, the infection rate among febrile cases was as high as 45% in the early resettlement period, while it was proved that the rate fell later to 1.9–14%. Judging from the environmental condition of this settlement area, this paper makes clear the persistent threat of malaria. Furthermore, among the villagers, hookworm infection was highly prevalent. However, liver fluke infections were scarce and no ascariasis was found from parasitic stool examination in 2007. Water quality analysis of the water sources resulted in remarkably safe water from tube wells from 2003 to 2008.

Keywords: Laos, Attapeu, relocation, ethnic minority, cholera, malaria, intestinal parasite.

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I Introduction

I-1. *Water-borne and Food-borne Infections in Lao PDR*

Lao PDR accomplished rapid economic development in the past two decades after the *Chinthanakaan mai* policy of 1986, with accompanying improvements of the health condition of the people [Nakamura and Iwasa 2008: 230]. However, water-borne and food-borne diseases, including severe diarrheal diseases such as cholera, dysentery and intestinal parasitic infections are still the most common threatening people in Lao PDR. According to government statistics, the major causes of death in 1995 (100,000 pairs of population) were malaria (7.62), ARI (Acute Respiratory Infections including pneumonia) caused by bacterial and/or viral pathogens (3.03) and diarrhea, including dysentery (1.69), meningitis (1.45) and tuberculosis (0.57), among others [Disease Statistics 1995: iii]. These trends show no change in the year 2005 [United Nations Country Team 2007: 29–30]. Hence, the water-borne infections like diarrhea and malaria are the most common causes of death. Water-borne disease is an illness caused by direct contact with water or aquatic vectors, containing causative microbes. In particular, water-borne disease is functionally common to food-borne infectious disease, for the causative microbe is taken orally. Infective diarrhea, for example, which is focused on food-borne viral, bacterial and/or protozoan agents, is seldom studied in Lao PDR and as such, research on food-borne diarrhea and food hygiene/sanitation has only just started in Laos [Agriculture and Rural Development Department & Rural Development & Natural Resources East Asia and Pacific Region 2006: 11–12]. Also, not many studies have been performed on bacterial diarrhea agents through field surveys in this country. However, some hospital-based or limited local diarrhea survey results are available. As a typical example of pathogen research in this country, there is the case report of the epidemic of cholera in 1993–96 [Midorikawa *et al.* 1996: 724–727] and a review of a severe diarrhea and cholera epidemic in 1998–2002 [Nakamura and Iwasa 2008: 229–246]. As for the causes of these epidemics, only *Vibrio cholerae* O1 Ogawa strains have been reported till the present [Midorikawa *et al.* 1996: 724–727; Phantouamath *et al.* 2001: 95–99]. Common bacterial diarrhea agents identified are enteropathogenic *E. coli*, *Shigella* spp., *V. parahaemolyticus*, *Campylobacter* spp. and *Salmonella* Typhi in Vientiane Capital [Yamashiro *et al.* 1998: 2195–2199; Phetsouvanh *et al.* 1999: 319–323; Phetsouvanh *et al.* 2006: 978–985]. Other infective diarrhea microbes related to parasitic helminthes such as roundworms, hookworms, tapeworms and liver flukes have been widely identified in the country [Phommasack *et al.* 2008: 1201–1206]. Some minor protozoan diarrhea agents such as *Entamoeba* spp. and *Giardia intestinalis* [Phetsouvanh *et al.* 1999: 319–323], as well as *Cryptosporidium* spp. and *Cyclospora* sp. have also been detected in Vientiane Capital [Takemasa *et al.* 2004: 7–12; Kimura *et al.* 2005: 1371–1376]. Regarding diarrheal virus identification, only Rotavirus in

Vientiane, [Yamashiro *et al.* 1998: 2195–2199; Phethsouvanh *et al.* 1999: 319–323; Phantouamath *et al.* 2004: 203–204] and Norovirus in Champasack [Watanabe *et al.* 2006] have been reported. Hepatitis A and E viruses have also been reported in Vientiane Capital [Bounlu *et al.* 1998: 717–721]. Moreover, others like *Leptospira* spp. [Suzuki *et al.* 1997: 436–437; Laras *et al.* 2002: 278–286; Kawaguchi *et al.* 2008: 957–961] and *Schistosoma mekongi* are known important water-borne microbes in Lao PDR [Matsuda and Kirinoki 2005: 143–156; Nakamura 2007: 217–227]. In addition to these studies, in the Mekong watershed in Indo-China the research on the infection risk analysis of water supply systems [Watanabe *et al.* 2006: 18–21] and the model study on local water risk analysis using GIS [Miura *et al.* 2007: 611–616] has proved to be useful.

The water-borne factor is also related to mosquito-borne infections like malaria and dengue fever, because the vectors originated from a water environment. Therefore as mentioned above, malarial death is common in Laos even today and remote rural populations living in or near forests or hilly areas alongside streams are at a particularly high risk [United Nations Country Team. 2007: 29].

I-2. *Background of Diseases, Control and Prevention*

The key background factors of such outbreaks of infectious diseases are malnutrition, especially among children, and insufficient clean water supply. Although many cases of malnutrition are observed in rural areas, the actual conditions of specific areas are not readily grasped, except in the case of a few in-depth studies [Kachondham and Dhanamitta 1992: 79–87; Boupha *et al.* 2003: 1–67; Miyoshi *et al.* 2005: 887–890]. On the other hand, it is commonly understood that maintenance of a clean water supply or sewer treatment is indispensable in controlling water-borne infections. As in Japan, jurisdiction over the water supply system of Lao PDR is divided between the Ministry of Public Works and Transport (MPWT) and the Ministry of Health (MOH). The former is responsible mainly for supplying drinking water through a piped water system in urban areas, and the latter for constructing tube-wells in rural areas. The Water and Water Resources Law was enacted in 1996 to ensure the maintenance of water quality. The drinking water quality standard in the health sector was enacted as law within the government in 2005, which required that *E. coli* is not detected in drinking water [Anonymous 2005: 7]. However, the efficacy of this microbiological standard is questionable, as access to safe water in rural areas was found to be only 35% in research on national health knowledge and attitudes towards drinking water [Steering Committee for Census of Population and Housing 2005: 118–119], and is not always reliable in the capital city either [Nakamura 2006: 37–41].

In 1978 to 1980, the Lao government carried out a campaign for the “three hygienes” (*sam sa-at*), promoting awareness of water, foods, and clothes in the prevention of water-food-borne infections among rural people [Boupa and Dalaloy 1997: 19]. This is a core idea of Primary Health Care (PHC) which will be mentioned later. The government

finally specified the responsibilities for the nation's health in the Constitution enacted in 1992, and further enacted the Hygiene, Prevention and Health Promotion Law in 2001, and the Law on Health Care in 2005. As for national food hygiene, the Law on Food was enacted in 2004, and related regulations on bottled drinking water standards were brought into force by the Ministry of Health in 2005. These laws are currently available to view on the internet website of the Embassy of Japan in the Lao PDR.

As such in Lao PDR, the implementation of health policies has been guided by a five-year health plan whereby the control policy corresponding to diseases in urban areas is hospital-based treatment. In rural areas, these policies are implemented by the PHC system together with primary medical treatment administered by Village Health Volunteers (VHV) and a public health campaign to prevent diseases [Anonymous 2000: 37–43]. The definition of PHC is that it “encompasses primary care, disease prevention, health promotion, population health (similar to public health), and community development within a holistic framework, with the aim of providing essential community-focused health care” [Shultz and Hatcher 1997: 23–26]. In Lao PDR, the government defined a public access range to PHC, which implies the least accessibility of the rural people to health facilities such as a dispensary at the village. This zoning is overlapped with *khet* or *koumban* (village cluster), which will be mentioned later.

On the other hand, these infections are closely related to poverty and the Poverty Reduction Strategy Paper (PRSP), supported by the IMF-World Bank, lays out an approach to improving health conditions through economic stimulus. In this strategy, the government specified 72 poor districts – including the 47 poorest ones — as a priority poverty reduction area. In addition to this, the National Growth and Poverty Eradication Strategy (NGPES) program included provisions for promoting health [Government of Lao PDR 2004]. In this strategy, agricultural and forestry, education, health, and transportation infrastructure are stated as priority sectors. The basic policies, priority issues, and projects aimed at eradicating poverty by the year 2010 are also described. NGPES is regarded as the core of the poverty reduction policy in the 6th National Socio-Economic Development Plan (NSED: 2006–10), which was approved by the government in 2006. It is also specified that the *koumban* should provide health care and PHC in mountainous resettlement areas that are home to ethnic minority groups [Evrard and Goudineau 2004: 945–946]. Moreover, water sanitation is a health sector priority in the strategy.

I-3. *Resettlement and Health of Mountain Ethnic Minorities*

Although the economy of Laos is developing quickly and living conditions and the livelihood of the people are also improving, the situation of the public health services in the mountainous poverty area mentioned is still not sufficiently improved. In many cases, health problems, such as increased mortality rates due to diarrhea, malaria, or intestinal parasites have been reported as an element of the process of resettling mountain ethnic minorities in Laos. Some important surveys were carried out to investigate

the general background and the food situation in these resettlement schemes [Ducourtieux 2004: 27–30]. According to Goudineau's report on resettlement in the 1990s, the relocation policy was originally based on the national policy to eliminate production of opium by ethnic minorities and to increase the convenience and effectiveness of minority groups' access to public services. The justification for resettlement was then changed to environmental protection, and more specifically the prohibition of swidden agriculture [Goudineau 1997. Vol. 1 : 29–36]. Even after the year 2000, reports also told about the case of the Akha, for example, in the northern part of the country, where the incidence of vector-borne fever and other infectious diseases had increased at their new villages. [Lyttleton *et al.* 2004: 62–66; Gonzales *et al.* 2005: 33]. In the results of investigations in 12 villages sampled from Luang Phabang, Saravane and Attapeu provinces, the major diseases were diarrhea and malaria. The studies showed that these diseases were still a threat to the people in the area [Sanogo and Vikan 2006: 14–15]. Furthermore, according to the Participatory Poverty Assessment (PPA) report of the UNDP, dysentery and malaria are still the major health issues in the villages surveyed for the previous PPA in 2000 [Chamberlain 2007: 54, 64].

II Objectives

In 2003 we started a health development study in collaboration with the Lao National Institute of Public Health, Ministry of Health to assess the risk of diseases in rural areas of the country. Before this, we had been investigating the situation of food-water-borne diseases in an area of Vientiane Capital where cholera had once occurred in 1999 [Nakamura and Marui 2000].

Regarding cholera, in the southern provinces, although the causative vibrios were not fully identified, an immunization program with a Vietnamese oral vaccine was conducted for the first time in Laos in some limited areas in Sekong and Attapeu provinces during 1995–96 [Nakamura and Iwasa 2008: 242]. Following this, however, 932 cases of another outbreak of cholera occurred in 2000 in all the districts of Attapeu province except Sanxay [Songsomsack and The Secretary's Team 2000: 2]. Therefore, we decided to investigate water-borne diseases in the province, where health care conditions are quite different from urban areas like Vientiane.

Our study aims to support the provincial health administration activities technically through improving recognition of, and ways of coping with, water-borne diseases among the local residents after an epidemic. Furthermore, support is provided through long-term observational studies to analyse health conditions related to water supply and water quality, including parasitic infections in the relocation area of Sanxay district, Attapeu province (Fig. 1), where the cholera vaccine had been administrated. The people moved from a hilly environment to the present lowland environment several years ago

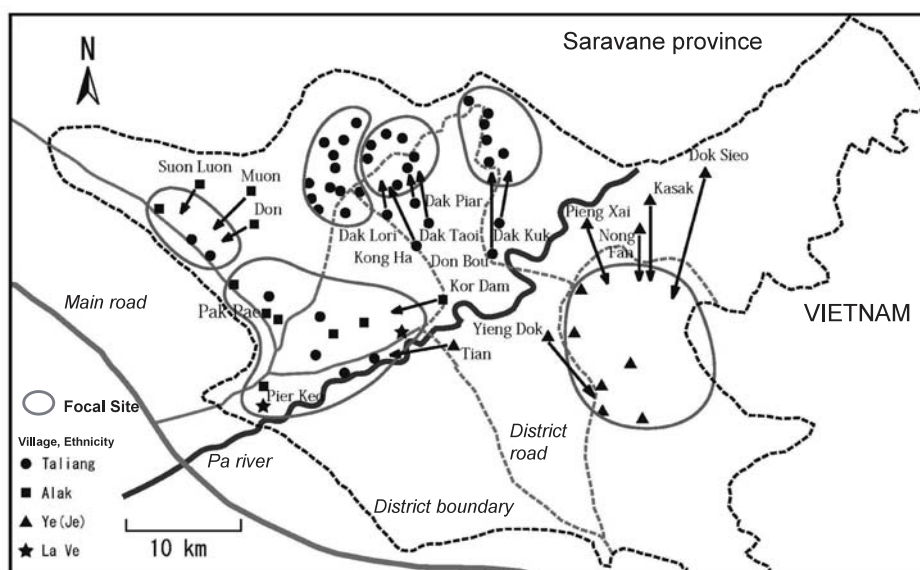


Fig. 1 Relocation for Forming Focal Sites in Sanxay District in Attapeu
 Note: Modification of the local administration map, 2001

and supposed to experience health risk at the initial stage of resettlement. Hence, we selected an investigation site in which both the infections and poverty overlap as an area.

Most data in previous reports was obtained by cross-sectional investigation in the northern part of the country, and there is little sustained field research on infectious diseases in the southern part of the country. The results of continued investigation on malaria and water-borne diseases in Attapeu province are presented in this article.

III Methods

III-1. Study Area

Attapeu province, the southernmost province in Lao PDR, has five districts: Samarkhixay, Sanamxay, Sanxay, Saysetha and Puvong, comprised of 208 villages with a total population of 91,259 (2000). According to the latest national census, the estimated crude death rate of the province was one of the highest (14.2 per 1,000 persons), comparable to Oudomxay (14.9) and Sekong (14.4) provinces [Steering Committee for Census of Population and Housing 2005: 107–111]. Several villages in the province (excluding Saysetha district) were selected for administering of a diarrhea knowledge survey.

Ban Pak Pae (Pak Pae village) in Sanxay district (Fig. 1) was selected as the site for a case study. The village was relocated in 2001 from its original mountain slope location to the present village site. The villagers are all from the Alak ethnic minority, numbering

128 people and 32 households residing in 29 houses in 2003. The known age group structure is shown in Fig.2. Their ancestors originated in Sekong province. About 80% of the people were given oral cholera vaccines during 1995–96 [Nakamura *et al.* 2004: 217–218]. Their mean annual income was 896,416 kip, with a range of 0–5,800,000 kip.

The largest change in livelihoods was the shift from upland swidden cultivation to unfamiliar lowland paddy cultivation. In the paddy fields developed around the new village, there is an increased risk of mosquito

populations which transmit malaria and/or Japanese encephalitis. On the positive side, the benefits of their new lifestyle include enhanced education for their children and increased access to medical services. However, villagers have to pay expenses associated with medical treatment. Therefore, people find themselves selling valuable livestock to obtain cash for medical service payments. Moreover, some comparatively rich people bought hand-tractors for paddy cultivation, but faced problems in purchasing fuel to run their new machinery. The village was merged with two neighboring villages and renamed Ban Phuxay (total population *ca.* 700) after 2007. However, in this paper, we will continue to use the original name.

Health personnel, such as health volunteers, and health kits have been available in the expanded village since 2007. Pak Pae villagers utilize two water sources for drinking water and daily use water. One is the Pa river water located 40 m near of the village, and the other is two shared tube-wells with hand pumps managed by villagers in the village. These wells were both 20 m in depth and were installed by AusAID in 2001. Villagers did not own private water sources like wells or ponds. The district hospital is located about 4 km southeast of the village. Nutritional status measured by BMI among 40 adult villagers sampled in Ban Phuxay indicated that almost half of the people are underweight (48%), while no cases of obesity were observed (unpublished observation in 2004 and 2008). The daily meals in this area consist of steamed rice and fermented fish sauce only.

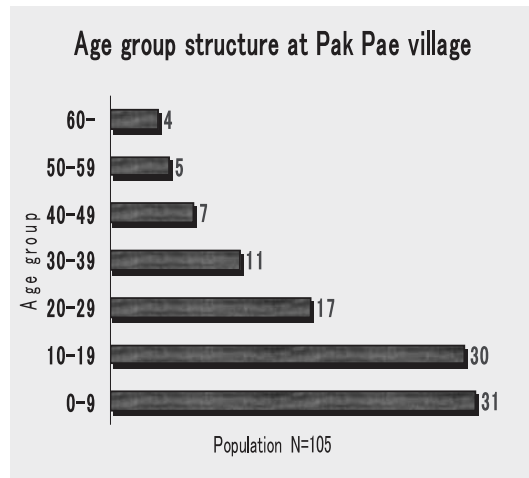


Fig. 2 Sanxay District, Attapeu Province in 2003

IV Study Methods

IV-1. *Diarrhea Awareness and Practices among Residents of Attapeu Province*

This investigation was conducted through an interview survey of households using a questionnaire in 35 villages from four districts: Sanxay, Sanamxay, Samarkhyxay and Phouvong, in February and March in 2006. These villages include: 7 villages of Dapokmam, Hindam, Hindan, Somboun, Souksavong, Then, Vanaxay in Sanxay district, 13 villages named Bok, Caoomphoy, Tatphyla, Hatuhao, Khang, Lanhum, Monang, Sapouan, Saisy, Smongtay, Somsanouk, Somsaypay, Thasengchanh in Sanamxay district, 10 villages of Isok, Khang, Samarkhy, Sekhamane, Somsanouk, Somsouk, Tha, Thahin, That, Xaysomboune in Samarkhy Xay district, the capital area of the province, and 5 villages of Lagnaoneumay, Naxeuk, Phomseat, Vangngong, and Vangnhay in Phouvong district. The population of these villages ranged between 300 and 1,100. The structured questionnaire included items such as diarrhea episodes of the past four weeks; knowledge of common names of different diarrhea, dysentery, and cholera diseases; knowledge of how to cope with diseases using medicines or medicinal plants; consulting traditional healers; seeking local medicinal plants; and actual prescription knowledge of the medicinal plants (See Appendix).

IV-2. *Household Health Survey in Pak Pae Village*

Questionnaire surveys were conducted at Pak Pea resettlement village in 2003 and in 2004 (See Appendix). For the household head or housewife, we asked through a structured questionnaire about occupation, animal husbandry, annual income, water sources and utilization, type of toilet used, ownership of electric goods and mosquito nets, annual illness episodes (especially febrile and diarrheal episodes) and their management in the last two years up to December 2003. These investigations were performed after full informed and voluntary consent was obtained. In 2004, a questionnaire survey on diarrhea and on fever/ malaria was conducted.

IV-3. *Water Quality Analysis in the Village*

Water quality, specifically bacterial contamination of water sources, was measured with the test-paper method [Midoriawa and Itokawa 1987: 740–746; Furusawa *et al.* 2008: 65–74]. The paper was immediately submerged into the water sample (Sun Chemical Co. Ltd.), and the *E. coli* colonies were numbered at 36°C after 24 hours. This count was the indicator of bacterial contamination, where no *E. coli* per 100 ml of water was the criterion for safe drinking water, as defined in the Lao standards [Anonymous 2005: 7]. The survey was conducted yearly from 2003 to 2008.

Microbial water analysis of the Pa river water was conducted in December 2007,

looking for contamination of *Entamoeba* spp. *Vibrio cholerae*, and norovirus. Forty liters of the sample water from the river was 1 : 400 concentrated using activated Diethylaminoethyl cellulose (DEAE) particle adsorption to detect the objective DNA sequences of pathogens using Polymerase chain reaction (PCR) method [Troll *et al.* 1997; Phetsouvanh *et al.* 2008; Yano *et al.* 1993: 295–298].

V Observation of Parasitic Infections in the Village

V-1. *Malaria*

When we visited the village in December 2003 there were many cases and fatalities from an unknown febrile disease suspected to be a malarial infection. Study of malarial infection rates and the number of malarial patients was started from December 2004. The study was conducted yearly during the dry season, until March 2008. Malaria parasites were examined with Giemsa stain of blood smears [Midorikawa and Hapue 1997: 31–35], PCR method [Arai *et al.* 1994: 617–626], and OptiMAL-IT(DiaMed)kits using 10 μ l of blood collected from the finger tip. Samples were collected by medical officers. Only those patients who agreed to be diagnosed were involved in the study. The number of villagers participating was 27 people in 2004, 59 in 2005, 63 in 2006 and 47 in 2008.

V-2. *Intestinal Parasitic Infection*

In December 2006, a total of 120 plastic bags were distributed to people who had remained at Pak Pea village. Stool examination using a routine formalin-detergent technique [Waikagul *et al.* 1997: 5–11] was also used to collect enteric parasites and eggs. For the stool sample collection, we distributed plastic bags to the people under the full given conditions of informed consent. Analysis of the samples was performed at a laboratory at the provincial hospital.

VI Results

VI-1. *Diarrhea Awareness and Practices*

The results of the questionnaire survey are shown in Table 1. Among 60 people interviewed, there was 1 case of diarrhea in the past 4 weeks. Although all the interviewees knew about common diarrhea and dysentery, with the exception of Xaysomboune and Sekhamane in Samarkhy Xay, all of them did not know the name of cholera and its characteristics. On the other hand, 80% of the residents knew some medicinal herbs to be used in case of dysentery or common diarrhea. The most commonly cited medicinal plant was Guava (*Psidium guajava* Linne). Of them, 70% used the plants as herbal tea (Fig. 3 A). Consulting a traditional healer at the time of diarrhea was rare, only occurring in 4 cases (7%).

Table 1 Knowledge of Diarrhea Diseases and Treatment Using Medicinal Plants in Attapeu, Lao PDR

District	Sampled Village	Sampled HH	Knowledge on (%)			Medicinal Plants Usage on (%)		
			Diarrhea	Dysentery	Cholera	Diarrhea	Dysentery	Cholera
Phouvong	5	14	100	100	0*	92.9	92.9	0**
Samarkhy Xay	10	15	100	100	13.3	66.7	66.7	0***
Sanamxay	13	15	100	100	0	66.7	73.3	0
Sanxay	7	16	100	100	0	100	100	0†
Total	35	60	100	100	3.3	81.6	83.3	0

Note: *N= 12, **N= 10, ***N= 14, †N= 15



A. Guava as Medicinal Tea

B. A Plant (*Azadirachta indica*) for Malaria Treatment**Fig. 3** Medicinal Plants for Prevention of Diarrhea and Malaria Treatment

VI-2. Household Health Survey at Pak Pae Village in 2003

Among the 24 households cooperating in the survey (75%), the main drinking water sources were well water (23 cases) and river water (1 case), as shown in Table 2. The practice of boiling water for drinking took place in 20 cases (83.3%), and there was toilet ownership in 3 cases (12.5%), while most of the people defecated on the ground in the forest. All the houses had tin roofs and walls made of bamboo. Personal property included a radio in 3 cases but no television set. Mosquito net ownership was found in 18 cases (75%). Animal husbandry included 28 buffaloes, 34 pigs, 101 chickens, and 31 ducks in 2003. With regard to eating habits and food supply, the people traditionally took meals twice daily, once each in the morning and the evening. Rice was the staple food, obtained from individual paddy fields. There was no rice surplus. Additional cultivation of maize was evidenced before the relocation. Cash income was made by the gathering and selling of rattan from the forest: a bunch of 100 pieces of small-diameter, about 20 kg in weight, could be sold for 20 to 30 US dollars in Vientiane. The actual selling price to traders at the village was 30,000 Kip per bunch. One man also earned wages by fishing, which was conducted on week-long trips.

Table 2 Results of Household Interview Survey on Selected Items at Pak Pae Village, Sanxay District, Attapeu in 2003

Item Interviewed	Number
Population	128
House	29
Family	32
Number of the house head/wife interviewed	24
Occupation: farmer	24
Mean annual income (Kip)	896,416
Animal husbandry: Buffaloes (population)	28
Animal husbandry: Pigs (population)	34
Animal husbandry: Chicken (population)	101
Animal husbandry: Ducks (population)	31
Drinking water source: Tube well	23
Drinking water source: The Pa river	1
Drinking water practice: drinking water after boiling	20 *
Drinking water practice: drinking raw water	4
Ownership of toilet	3
Ownership of radio	3
Ownership of television	0
Ownership of mosquito net	18
Number of smoking habit (population)	48
Awareness of drug abuse	23

Note: * In some cases some did drink raw water or river water but boiled the water before drinking

Table 3 Disease Episodes from Interviews at Pak Pae Village in 3 Years from 2002 to 2004

Disease	2002	2003	2004
Malaria/Fever	16 (36)	15 (36)	26 (75)
Diarrhea	10 (29)	7 (16)	18 (43)
Dysentery	9 (27)	4 (7)	NA
Helminthes	3 (13)	1 (5)	NA
ARI	5 (6)	1 (2)	NA
Measles	3 (9)	0	NA
Others	1 (1)	3 (4)	NA

Note: NA: not asked

Number in parenthesis is total case of episode

The disease episodes reported during the year 2002 were as follows (Table 3): fever was experienced in 16 households (66.7%) accounting for a total of 36 cases, of which only three were referred to the district hospital, and at least 1 case was consulted by health personnel. In the same year, 9 cases of measles were observed from 3 households (12.5%). Diarrhea was experienced in 10 households (41.7%); among 29 cases, one consulted health personnel. The households experiencing dysentery totaled 9 (37.5%), with only one case out of an estimated 27 consulting a health worker. The known helminthes

infection was 3 households (12.5%), which included 13 cases. There were at least 6 cases of ARI in 5 households (20.8%). Others reported problems included injury, where only 1 household was concerned.

For the following year 2003, the reported cases were as follows: households experiencing cases of fever (suspected to be malarial) numbered 15 (62.5%). Four out of an estimated 36 cases were referred to the district hospital and at least one case consulted a health worker. There were 7 (29.2%) households experiencing diarrhea and among these, 16 cases consulted a health worker; 4 (17%) households experienced dysentery, and 1 among 7 estimated cases consulted a health worker, whereas only one household was aware of helminthes infection, with 5 cases in the family. There were 2 cases of ARI from the same household (4.2%); 3 households including 4 cases reported injury, two of which were referred to the district hospital. In the year 2004, about 18 (66%) of the interviewees experienced diarrhea and the total cases of diarrhea including the village members was 43 cases.

VI-3. *Microbial Contamination of the Drinking Water Sources*

No *E. coli* contamination was confirmed at the two shared tube-wells with hand pumps managed in the village in the annual surveys administered since December 2003. Before the resettlement, the people were using river water boiled at the mountainside village. People used to drink tea from guava leaves and medicinal wood tip for diarrhea prevention. However, they usually drank unboiled water in the fields at that time. The Pa river water contained 1,700 coliform bacteria per 100 ml, indicating that the water was not suitable for drinking. However, no norovirus or *Entamoeba* species was detected, although the river might contain non-O1 non-139 *Vibrio cholerae* related strains which have a common DNA sequence with *V. cholerae* O21, which was confirmed by the PCR.

VI-4. *Infectious Diseases in the Resettlement Village*

VI-4-1. *Fever and Malaria*

In December 2004, interviews and blood collection were performed by 27 village health volunteers to detect malarial infections in 16 households. The age range of the sample was 13–70. The number of unknown febrile episodes among interviewees and among their family members was 26 (96%) and 75 cases, respectively. At least two malaria cases were detected on site by microscopy. However, 13 out of 27 persons (44.8%) were infected with *Plasmodium falciparum*, later confirmed by PCR. In 2005, only one falciparum malaria case among 59 displaced people was confirmed (1.9%) with a rapid test kit. In 2006, a total of 63 displaced people were examined for malaria by rapid test; 9 cases (14%) had falciparum malaria or mixed infection from *P. falciparum* plus *P. vivax* (vivax malaria). These cases were all in children under 15 years old. Among the cases, three were severe cases sent to the district hospital immediately. Another one was an adult vivax malaria case. In 2008, 3 falciparum malaria cases (6.4%) among 47 consulting cases

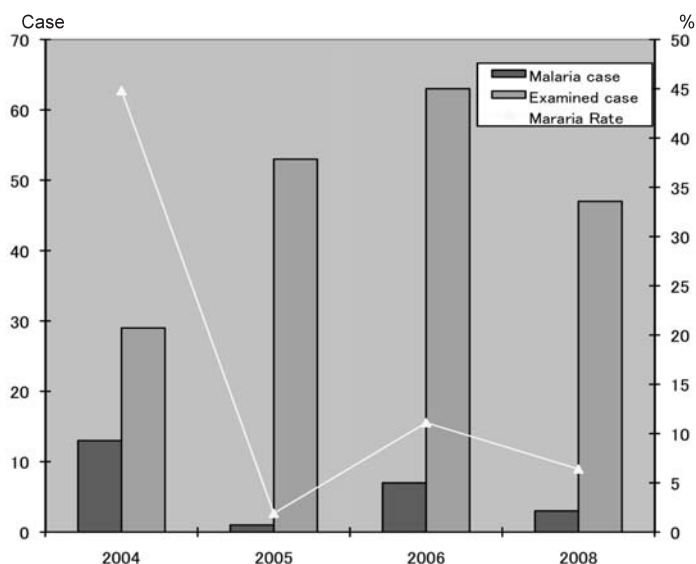


Fig. 4 Malaria Infection per Year from 2004 to 2008 at Pak Pae Village, Sanxay, Attapeu

were confirmed. The decreasing incidence tendency of malaria is shown in Fig. 4.

VI-4-2. Intestinal Parasites

A total of 79 samples were recovered. Within the sample, 44 samples contained some sputa or blank. Therefore, 35 out of the 10 households' stool samples (29%) were recovered. As for the results, 29 hookworm infections, 16 *Trichuris trichiura* infections, and 2 liver fluke (*Opisthorchis viverrini*) infections were confirmed (Table 4). The averages of the number of eggs in each 1 g (EPG) were 623, 99 and 49, respectively. In terms of age distribution, 30% of the infections were in children aged 15 years or less. However, this finding was influenced by the age structure bias of the sample (Table 5). Moreover, although 40% of cases had heavy infection, especially for hookworm and *T. trichiura*, there was no gender difference in case repartition. Concerning protozoan

Table 4 Results of Intestinal Parasite Infections at Pak Pae Village in Sanxay, Attapeu in 2007

Egg of Parasite*	Case	Per cent Rate	Mean EPG**
Hookworm	29	82.9	623.1
<i>Trichuris trichiura</i>	16	45.7	99.7
<i>Opisthorchis viverrini</i> .	2	5.7	49.7

Note: * Modified Formalin-detergent method [Waikagul *et al.* 1997]

** Egg per 1 g

Table 5 Parasitic Infections by Age-group at Pak Pae Village in 2007

	< 5	6–15	16 <	Total
No parasite	3		3	6 (17.1)
Hw	3	2	8	10 (28.6)
Hw + T		2	9	14 (40)
Hw + T + others		1	1	2 (5.7)
Hw + others		1	2 *	3 (8.6)
Total	6	6	23	35 (100)

Note: Hw: Hookworm, T: *Trichuris trichiura*

* A case of *Giardia intestinalis* infection and an *Entamoeba* sp. infection case were included.

infection, a *Entamoeba* sp. case and a *Giardia intestinalis* case were confirmed, both in adult males.

VII Discussion

It is surprising that, according to our results on awareness of diarrheal diseases, the local people were apparently not aware of cholera. This is despite the fact that provincial health staff had provided health education for prevention of cholera during every diarrhea epidemic in the region since 1996 [Songsomsack and the secretary's team 2000: 2]. A report of the cholera education team told that they provided interventions at 68 villages (24.3%) in the 5 districts from 1999 to 2000 (Report of cholera education in Attapeu province 1999–2000) when the last cholera outbreak occurred in the region. The report also revealed that an insufficient budget for local government resulted in both short time and low motivation among the work team as well as a lack of the relevant education materials. Furthermore, the same report pointed out that few participants were attending the intervention sessions because of their work in the rice fields. In 1997 and afterwards, the Lao government stopped using the term “cholera,” in order to protect the country's trade profits on trade except for the 2000 epidemic [Nakamura and Iwasa 2008: 242].

In relation to water safety among the studied village population, most people prefer to use the safe (pathogenic bacteria-free) tube well water, and only one case reported drinking non-boiled river water. It is not clear why tube well water was not used in the latter case. The river water PCR revealed that it might contain a *V. cholerae* O 21 related strain [Nakatsu *et al.* 2008]; this means that the water source will bear a risk of vibrio infection [Phetsouvanh *et al.* 2008]. Although most of the villagers were using clean well water for drinking, there were many diarrhea episodes annually. It should be noted that the causes were chronic malnutrition among the people, food contamination due to

unclean food handling, or polluted teacups and/or cookware usage, among others.

We do not have comprehensive data on malaria infection from 2002–03 after the Alak people relocated from the mountain area to the plain area. However, in Sanxay district, the rate of malaria infection is comparatively high within the province [Phetsouvanh *et al.* 2004: 547–551]. However, we observed a large number of fever cases. It can be estimated that the remarkable spread of malaria began among these people immediately after migration and persisted until 2004. At the beginning of these malaria outbreaks, people could not cope with the disease. Instead of using medicine for malaria such as chloroquine or quinine, people in Pak Pae village tried to collect and use grass and herbal teas that were not effective at that time. The use of traditional treatments can be summarized as: (1) The villagers thought that those grass and herbal tea were effective for malarial parasites. (2) They had no idea of anti-malarial medicines such as chloroquine. (3) In fact, even if they had the knowledge, medicines such as chloroquine and quinine were too expensive for them to buy. The medicinal herbs that they used as a malaria treatment were sold on the Attapeu market in 2004 disappeared from the market after 2005 (Fig. 3 B). This means that migrating people in Pak Pae village had learned better methods and used effective anti-malarial medicine. For the prevention of malaria, the focal site including Pak Pae village is located along with Pa River, which flows throughout the dry season. This means that the malaria vectors can breed there year-round. As an example, the malaria infection rate in Pier Keo village (La Ve ethnic group), located 7 km from Pak Pae, was as high as 40%, and the vector mosquito has been identified as *Anopheles dirus* [Sidavon *et al.* 2004: 309–315]. Recently, it has been shown that ordinary mosquito nets do not prevent malarial infection, because even though the distribution of nets has been completed, people are still being bitten by mosquitoes [Vythilingam *et al.* 2005: 833–839]. Moreover, it is pointed out that their house structure is not what can fully prevent invasion of mosquitoes either. In addition, concerning falciparum malaria, although drug resistance is a little lower in the southern part as compared with northern Laos, the genotype variation analysis showed that chloroquine-resistant mutagenicity was about 100% in Attapeu and the adjacent provinces of Sekong and Champasack, thus a combination of medicine other than chloroquine is needed for medical treatment in the near-future [Mayxay *et al.* 2007: 36–43]. For these reasons, the risk of malaria infection from the vectors in this area is considered high, even in the future. Hence, systematic and immediate countermeasures, such as easier access to therapeutic facilities, and the improvement of housing are essential.

NGPES specifies that intestinal parasitic infections may still be a threat to people in relocated communities [Government of Lao PDR 2004: 89]. The sample size in our investigations at Pak Pae village was small, and thus sufficient conclusions cannot be drawn. However, the rate and intensity of hookworm infection was demonstrated to be very high. Interestingly, no *Ascaris lumbricoides* infection case was found despite the fact that it is very common in both urban and rural settings in Laos [Phathamavong *et al.*

2007: 689–694; Erlanger *et al.* 2008: 223–242]; the liver fluke infection rate was also very low. This may be explained by the fact that the people's resettlement time from the mountains to lowlands was short and eating habits did not change. There are still significant differences with lowland diets; for example, relocated uplanders do not eat raw foods, such as fish.

VIII Conclusions

Our continuous and cross-sectional studies in the resettlement village clearly demonstrate that febrile diseases, especially malaria, are still a threat to the people, and control measures are needed in the area. If the conditions of one's living environment change, the kind of infections acquired will change and countermeasures towards them must change as well. Migration into areas where the health service system is not well developed raises the risk of infectious disease, as shown in the research site. There should be a simultaneous effort to increase government-led countermeasures and awareness-raising. These public health measures will have a high impact on local peoples' nutrition conditions, which is a critical part of poverty eradication, and thus should be coordinated closely with these socio-economic development strategies locally.

The cases of diseases demonstrated in this study are similar to those previously performed in Lao PDR. [Ducourtieux 2004: 27–30; Gonzales *et al.* 2005: 33; Sanogo and Vikan 2006: 14–15; Lyttleton *et al.* 2004: 62–66], and are closely related to agricultural subsistence problems. In particular, people's nutrition status is the most important factor for the prevention of communicable diseases. Although technical guidance, particularly in connection with rice production, is not described in the NGPES, it is thought that a stable supply of rice and its surplus are especially important for health promotion in the area. Hence, further investigation should be performed, with special emphasis on anemia and nutritional status, and put in relation to communicable diseases including intestinal parasitic infections. A major implication of this study is that the local government should continue to grasp disease structure to increase health care services, and especially in the resettlement areas, it is necessary to consider the public health service program corresponding to inevitable change of the living environment.

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Appendix

Questionnaire items for diarrhea survey in Attapeu province, February-March, 2006

1. Name of village, district, and date of interview;
2. Total population, and number of households;
3. Name of interviewee, age and sex;
4. Have knowledge on: common diarrhea, dysentery, cholera;
5. Know some plant remedies for: common diarrhea, dysentery, cholera;
6. If positive response to 5: self treatment with plants for diarrhea; usages with help of medicine man; knows where to collect medicinal plants; know how to prepare plant remedies;
7. Diarrhea episode in the preceding 4 weeks;

Baseline data survey items on Ban Pak Pae, Sanxay district, Attapeu province, December, 2003

1. Village: , House number: , Answered by: , Name of enumerator: , Date of interview: ,
2. Household information: Number, Name, Sex, Age Relation, Occupation, Schooling, Place of living;
3. Animal husbandry: Number of: Oxen Cow, Buffalo, Pig, Goat, Sheep, Chicken, Duck, Goose, other;
4. Household income in the last year (Kip): Regular income/Salary, Wage labor, Selling crop, Selling animal, Remittance, other, Total income;
5. Loans;
6. Water resource; Availability, drinking practice, utilization purposes, taste, and volume: Tube well, Dug well, Tap water, Fountain, River, Pond, Weir, Rain water, Tank, Bottled, other;
7. Ownership of the wells;
8. Toilet: No toilet, Outside on ground, River/Canal, Bore hole/Pit, Latrine with water, Flush toilet, other;
9. Housing: Traditional style house made of: Bamboo wall, Wood, Bamboo and wood wall, Wood and cement/block; completely block build house;
10. Possessions: Radio, Television, Refrigerator, Tape-recorder, Bicycle, Motorbike, Thak-Thak, Jambo, Tuk-Tuk, Automobile;
11. Disposition of daily wastes/garbage: Fixed place, Routine collection, Scatter around the house, other;
12. Disease and consultation: Number of disease cases in your family if you aware at present year (2003) and in the last year (2002). And with whom she/he consulted the case.; Disease: Common cold/ARI, TB, Malaria/fever, Diarrhea, Dysentery, Helminthes, Tetanus, Dengue, Polio, Measles, Diabetes, Cancer, Animal bite, Accidental Wound, other
13. Usage of bed net; Smoking habit: Information awareness on drug abuse.

Questionnaire items for diarrhea and fever/malaria survey at Pak Pae village, Sanxay district, Attapeu province in December 2004

1. Date of interview, Name of surveyor, Interviewee: name, age, sex, Number of the household;
2. Experience of the cholera vaccine during 1995-96;
3. Interviewee's episode on severe diarrhea and/or abdominal pain in the year;
4. The family members' episode on severe diarrhea and/or abdominal pain in the year;
5. If replied to 4, check the number of people with the episode;
6. Interviewee's episode on fever and/or malaria in the year;
7. The family members' episode on fever and/or malaria in the year;
8. If replied to 7, check the number of people with the episode.